U.S. Environmental Protection Agency
Office of Science Policy
Regional Science Workshop on
Wetlands and the Evaluation of Ecosystem Services in a Watershed Context
Hilton Salt Lake City Airport
5151 Wiley Post Way
Salt Lake City, UT 84116

September 26–27, 2007
MEETING SUMMARY

September 26, 2006

Welcome

Brian Caruso, U.S. Environmental Protection Agency (EPA) Region 8, Denver, CO

Jill Minter, EPA Region 8, welcomed participants to the meeting and thanked them for their interest and attendance. She explained some logistics regarding the meeting location and introduced Brian Caruso.

Dr. Caruso manages the Wetlands and Watershed Units for EPA Region 8. His work includes the Clean Water Act (CWA) Section 404 program, jurisdictional determinations, wetland monitoring and assessment, and building capacity for state and tribal wetland programs.

This is a Regional Science Workshop, sponsored and organized by EPA's Office of Research and Development (ORD) and its Office of Science Policy (OSP) in conjunction with Region 8. The goal of the workshop is to make plans for an ecosystem research program, and attendees at this workshop are experts in ecosystem services. The workshop is intended as a research planning activity with the overall goal of protecting wetland quality and quantity throughout the United States and particularly in the Great Salt Lake. To achieve this, better methods are needed for assessing, monitoring, understanding, and placing value on wetland ecosystem services. Ecosystem services must be defined; this may be easier to accomplish by placing the above factors in an ecosystem services/economic context.

This workshop will explore: (1) ecosystem services and the research planning process, (2) wetland assessment, (3) water quality trading, (4) integration of water quality with wetlands habitats, and (5) how these concepts can be applied to the Great Salt Lake ecosystem and its associated watersheds. The goal is to ensure that high-quality science is being used for decision-making. The ecosystem services research plan includes four main topic areas: (1) place-based research, (2) wetlands, (3) nutrients, and (4) ecosystem services. Although the Great Salt Lake is not a primary focus of EPA's place-based research, Region 8 is conducting pilot research on this ecosystem that can be implemented in ecological decision-making for the lake and wetlands. This research will be integrated with overall environmental decision-making for the watershed to protect wetlands.

The Regional Applied Research Effort (RARE) Program is one approach EPA takes to promote collaboration between the regions and ORD. EPA wetlands staff have been awarded a competitive research grant for internal research under this program. This RARE project involves alternative futures in Farmington Bay and is one of a number of EPA research activities in the Great Salt Lake, such as surveys of wetland quantity and quality, classification, and mapping, all of which are integrated into the proposed Great Salt Lake Wetland Goals Project. This Goals Project would create a program to monitor Great Salt Lake wetlands, examine habitat changes over time, and provide science and information for future management decisions.

Another goal of the workshop is to examine how processes and activities of the EPA National Ecosystem Services Research Plan can be integrated into the RARE project and the Great Salt Lake Wetland Goals Project. Region 8 has made the Great Salt Lake a regional priority and has committed resources to achieve these goals. Since 2000, the region has provided $1.8 million toward wetlands research to support state capacity building for wetlands protection. Additionally, Region 8 has created the position of Great Salt Lake Coordinator for one of its staff members and committed additional staff and time to the effort.

The goal of the Great Salt Lake Wetland Goals Project is to improve water quality and wetlands habitat in the Great Salt Lake; the challenge is to determine how to best move forward to integrate this goal into a watershed context. There are many agencies working on the Great Salt Lake and associated wetlands that have different goals, programs, and regulatory authorities. It is necessary to coordinate the work of these agencies. The effect of development pressures and point and nonpoint source loading on the lake's water quality and wetlands must be examined. Current work in this area includes beneficial use analyses, special topic areas of examination (e.g., mercury, nutrients), water quality standards development, and future total maximum daily load (TMDL) development.

During this workshop, attendees should consider how to: (1) integrate the issues discussed, (2) contribute to the EPA Ecosystem Services Research Plan, (3) integrate research into the RARE project, and (4) establish collaborations. The ultimate goal is protection and restoration of the habitat for shorebirds and waterfowl, but there are many factors within the watershed that contribute to this protection.

A participant asked for clarification regarding the full-time staff member who will be devoted to Great Salt Lake issues. Dr. Caruso responded that Jim Berkley, who is in attendance at the workshop, has been selected for this effort.

Ying-Ying Macauley, Utah Department of Environmental Quality (DEQ), Salt Lake City, UT

Ying-Ying Macauley welcomed participants to the meeting and explained that she would provide information on Great Salt Lake programs and anticipated challenges. Utah DEQ is in the process of investigating subdividing the Great Salt Lake for ease of water quality assessment. The Great Salt Lake is currently classified as one water body and lacks numeric water quality standards. It is protected for primary and secondary contact recreation, waterfowl, shore birds, and other water-oriented wildlife—including necessary aquatic organisms in their food chain—and mineral extraction.

The Great Salt Lake is the largest lake west of the Mississippi River and the fourth largest terminal lake in the world, measuring more than 3,000 square miles. It is three to five times saltier than the ocean, with an average depth of 13 feet. Currently, the maximum depth is 35 feet, but water levels fluctuate by 10 feet during 20 year cycles. The lake supports between 2 and 5 million shorebirds, mineral and chemical extraction, the brine shrimp industry, waterfowl organizations, and recreation. The Great Salt Lake is home to 98 percent of the state's swans, 70 percent of its ducks, and 31 percent of its Canada Geese and supports 85 percent of Utah's wetlands. Greater than 80 percent of the state's wastewater flows into the Great Salt Lake. During times of elevated water levels, the lake expands significantly.

Two existing causeways divide the Great Salt Lake into four subsections: Gunnison Bay, Gilbert Bay, Bear River Bay, and Farmington Bay. The bays are characterized by different salinities, flow rates, and interactions. A fifth category of subdivision could be the fringe wetlands. The effluent-dependent nature of some of the wetlands complicates the assignment and definition of subsections.

The nearby Bingham Canyon Copper Mine is the second largest open pit copper mine in the world and is marked by a contaminated plume that radiates from the mine's center. Attempts to extract contaminated water for reverse-osmosis treatment have not been successful. Of 11 potential options to dispose of the

wastewater, two have emerged as viable: (1) discharge to the Jordan River, or (2) discharge to the Great Salt Lake.

The Utah Water Quality Board has the authority to adopt water quality standards. It decided to organize a steering committee (Great Salt Lake Water Quality Steering Committee) for two studies: one involving selenium and the other involving Farmington Bay. A scientific panel associated with the selenium study is comprised of national experts and led by Bill Moellmer of Utah DEQ. The Farmington Bay study is headed by Theron Miller of Utah DEQ. The purpose of the steering committee is to: (1) create a partnership among stakeholders, (2) conduct a transparent public process, (3) establish a science panel, (4) sponsor and guide scientific research, (5) assist in securing funding, (6) adhere to state and federal laws and regulations, and (7) make a recommendation to the Division of Water Quality on a selenium standard for the Great Salt Lake. The steering committee is comprised of members from state and federal government, industry, and nonprofit organizations. The Great Salt Lake Science Panel is comprised of nine members.

The purpose of the selenium study is to understand the mineral's life cycle and determine the transport of selenium into sediments, algae, brine flies, and brine shrimp and ultimately to ascertain its effect on the birds that ingest brine flies and shrimp. The study is comprised of four components to determine: (1) inputs; (2) output, bioaccumulation, and toxicological endpoints in the food chain; (3) output to atmosphere via the vapor phase; and (4) output to sediment via permanent burial. Following 3 years of research, the science panel currently is writing the recommendations for numeric standards, which should be available by February 2008. The data are being examined, and the steering committee will present its recommendations to the Division of Water Quality by March 2008.

Because the Great Salt Lake has some of the highest levels of mercury found in U.S. surface waters, mercury advisories have been issued on nine water bodies and three species of ducks associated with the lake, and a Web site has been established regarding this issue. Funds were secured to obtain sediment samples, analyze the water column, and collect avian tissue. Attempts to secure an additional $147,500 to establish a full-time mercury coordinator, collect 500 samples per year, and evaluate hot spots were not successful because the state legislature did not consider this a high priority. The Mercury Work Group is comprised of members from state and federal government, industry, and nonprofit organizations. Its purpose is to: (1) provide Utah residents with current, accurate, and understandable information; (2) develop an ongoing monitoring program; (3) share information; (4) coordinate and collaborate efforts; and (5) provide mercury advisory information. The next steps for the work group are to: (1) finalize the mercury source protocol; (2) execute a memorandum of understanding (MOU) with Nevada, Idaho, and EPA Regions 8, 9,and 10 to pool resources; (3) continue to pursue funding; (4) continue Great Salt Lake monitoring and complete the initial study; and (4) solicit regional and national interest. If additional funding can be secured, these efforts can be enhanced.

Farmington Bay nutrient pollution studies also are underway. Farmington Bay is an important feeding and nesting ground for migratory birds; supports waterfowl, shorebirds, and aquatic life in their food chain; and is used for a variety of recreational activities. A state award is supporting analysis of water quality, macroinvertebrate, and vegetation factors of Farmington Bay, but the primary issue is eutrophication of the bay. The central question is whether phosphorus is impairing the beneficial uses of the wetlands and open waters of Farmington Bay.

The total budget for all Great Salt Lake studies is approximately $3 million, which is provided by several state and federal government, industry, and nonprofit sources. This is low compared to the budgets of the Chesapeake Bay Program ($15 billion over 6 years), the Great Lakes Commission ($20.5 million annually), the Puget Sound Partnership ($245.3 million annually) and other wetlands programs and initiatives. Working within this budget, the next steps are to: (1) institute a Great Salt Lake Watershed

Council as a precursor to establishing a Great Salt Lake Commission; (2) investigate long-term funding mechanisms for research and protection of the Great Salt Lake; and (3) solicit interest in the Great Salt Lake at the state, regional, and national levels. The goal of the Great Salt Lake Commission will be to oversee all components of the Great Salt Lake, including water quality, watershed management, wildlife management, political entities, regulatory issues, and so forth. State Revolving Fund (SRF) monies may be used to support some of the Great Salt Lake projects that are eligible for SRF funding. Long-term funding is needed to establish the Great Salt Lake Commission and support scientific decision-making.

A participant asked how many birds the Great Salt Lake supported before the area was settled. Ms. Macauley responded that she did not have historical numbers.

A participant noted that much of the focus is on Farmington Bay and asked whether there were any efforts to work with Idaho and Wyoming on the Bear River. Ms. Macauley explained that eutrophication of the Farmington Bay led to that focus. Utah is involved with the Bear River Water Quality Task Force.

Wayne Martinson, National Audubon Society, stated that the interaction of some of the bays had been examined, and the Bear River Bay contributes more nutrients to Gilbert Bay than Farmington Bay. A participant added that if the causeways were not present on the Great Salt Lake, then it would be feasible to use two or three subdivisions. Ms. Macauley agreed and stated that changes in hydrogeologic conditions also influence divisions.

Richard Sumner, EPA Office of Water Wetlands Program, asked participants if a barrier existed between those groups that have a water quality focus versus those with a habitat focus. Dr. Miller responded that historically there is a barrier; it is not intentional and is the result of two different goals. There is a need for collaboration. A participant remarked that there has been no communication. Another participant added that it will take time to change the incorrect perception that water quality is uninterested in habitat. Another participant observed that measurable parameters are important in the public view. Mr. Sumner commented that an ecosystem services language could be created that brings the two groups together. A participant stated that communication is not the only problem; the Great Salt Lake is very large with a great deal of cumulative impact. Ms. Minter commented that it is correct to call attention to scale issues. Often, the extremes of site and landscape scales are examined, but mid-scale examinations also are needed.

Keynote Presentation: What Are Ecosystem Services and How Might They Be Evaluated?

Rick Linthurst, National Program Director (NPD), EPA Ecological Research Program, Research Triangle Park, NC

Rick Linthurst recommended that participants read the Millennium Ecosystem Assessment. The Millennium Ecosystem Assessment is the largest assessment undertaken to determine the health of ecosystems and the consequences of ecosystem change for human well-being. The Board's statement was prepared by 1,360 experts from 95 countries and underwent extensive peer review. It is a consensus of the world's scientists. The statement was designed to meet needs of decision-makers among the government, businesses, and civil society.

The foundation of the assessment is that ecosystem services are comprised of four categories: supporting, provisioning, regulating, and cultural. Aesthetic and spiritual, subcomponents of the cultural category, are difficult to quantify but are significant. The constituents of well-being—security, basic materials for good life, health, social relations, and freedom of choice and action—are derived from ecosystems services. Fifteen of the 24 services examined are declining globally.

A key finding of the Millennium Ecosystem Assessment is that today's technology and knowledge can reduce considerably the human impact on ecosystems. Technology and knowledge are unlikely to be deployed fully, however, until ecosystem services cease to be perceived as free and limitless; their full value must be taken into account. One driver for EPA to consider the full value of ecosystem services is an executive order to examine cost/benefit of regulations, including ecosystems. Other drivers include: (1) the Administrator's charge to advance environmental protection while maintaining economic competitiveness; (2) the increased emphasis on environmental stewardship and information to make better decisions without regulation; (3) the sustainability of ecosystems/services as an Agency theme; and (4) urban sprawl and rapid loss of natural areas.

Sustainable human well-being must be cast in terms of social capital, built capital, natural capital, and human capital. The challenge to ecologists is to transform the understanding of, and response to, environmental stressors by clarifying the ways in which human choices affect the type, quality, and magnitude of the services afforded by ecosystems (e.g., clean air, clean water, productive soils, and generation of food and fiber). To accomplish this, it is important to realize that ecosystem services do not always follow the most desirable boundaries, such as watersheds. Rather, the term ecosystem district is used to define an area where management boundaries are logical; it is a spatial boundary that delimits a core geographic area for the purpose of efficient, simultaneous management of multiple ecosystem services. Ecosystem services can be defined as the current and future outputs of functioning, complex ecological systems that are enjoyed, consumed, or used by humans and that support their well-being, either directly or indirectly.

Dr. Linthurst described eight compare scenarios for the Willamette River, each with increasing land conservation. As biodiversity increased, commodities decreased. Biodiversity is not easily monetized as compared to commodities, despite that it is generally understood from ecological principles that high diversity is presumed to be a measure of a more stable, long-lasting ecosystem. Analysis of these scenarios illustrates how both biodiversity and commodities can be achieved by making certain tradeoffs, thus leaving a more "healthy" ecosystem district. The challenge is how to aggregate these different outcomes for the selection of those that achieve the goals of the community. The net value of services may be examined with weighting, such as public value surveys, economics, or other methods. The science needed to best achieve this goal is not currently available. One practical example is the Midwest biofuels situation. If scenarios were defined, actions taken to grow more corn modify the landscape, hydrology, water quality, emissions, and air quality, thus affecting a variety of services. These effects then are analyzed, and the broader ecosystem change picture emerges. It is this more complete picture that would be best analyzed, as in the Willamette example, to attempt to find the conditions that maximize ethanol production while minimizing ecological service losses.

There are two methods by which to accomplish an ecosystem services approach. The first method is the "one-system, one-service" approach. If nutrient retention is thought about as a wetland service and nothing more, there are some relatively easy approaches to making decisions. A drawback to this approach is that additional wetland services may be missed that are equally important to the whole of the system, for example recreation, water retention, flood protection, and so forth. A better approach is what some refer to as the "art of the possible," which envisions all important services such that optimal arrangement of multiple services is achieved. This second approach is extremely complex, as are ecosystems, and is likely to yield a more environmentally friendly result.

EPA's Ecological Research Program (ERP) is taking a three-pronged approach to this problem, using pollutant-driven ecosystem services research, ecosystem-driven ecosystem services research, and place-driven ecosystem services research. Pollutant-driven research investigates how a regulated pollutant affects the collection/bundle of ecosystem services at multiple scales. Ecosystem-driven research examines how the collection/bundle of ecosystem services provided by a single ecosystem-type change

under alternative management options at multiple scales. Place-driven research studies how the collection/bundle of ecosystem services for all ecosystems within an ecosystem district change under alternative management options and drivers.

A participant asked if the Millennium Ecosystem Assessment took other countries into account to see if ecosystem imbalances result from economic differences. Dr. Linthurst answered that this variable was considered and research confirmed that these imbalances do exist. In fact, some of the grossest differences in the use of services come from examining poorer countries.

A participant asked if any ecosystem services districts currently were charging fees for services. Dr. Linthurst replied that to the best of his knowledge, fee arrangements still were quite rare. One can imagine, however, examining a district that wants to reduce nitrogen inputs and could seek that reduction by many different means including publicly owned treatment works, agricultural fields, changes in air regulations, and so forth. It must be considered, however, that a district is merely a common sense boundary.

A participant commented that ecosystem services impacts occur not just 5–10 years out, but 100–200 years out. He asked for an identification of the challenges across time. Dr. Linthurst responded that the challenges are unknown at that time scale. Most scenarios, however, are in the 20–50 year timeframe when conducting these analyses. In timeframes shorter than this, the changes may not be apparent; in longer timeframes, the uncertainty is too great.

Joseph Schubauer-Berigan, EPA, ORD, National Risk Management Research Laboratory (NRMRL), asked if there is a risk of overlooking a keystone network function that is important for sustainability. Dr. Linthurst responded that he was unable to answer this question. Dr. Schubauer-Berigan commented that it is important to consider this.

Framework for Assessing Wetlands and Their Associated Ecosystem Services

Mary Kentula, EPA, ORD, National Health and Environmental Effects Research Laboratory (NHEERL), Corvallis, OR

Mary Kentula emphasized that ecosystem services must be a factor in decision-making; otherwise, the consequences may be disastrous. In determining the value of ecosystem services across a variety of ecosystems, Costanza et al. (1997) reported that the value of wetlands was more than 50 percent of the total, providing more value than coastal, forest, grassland, lakes/rivers, and cropland ecosystems combined. The wetlands goal of EPA's ERP is that between now and 2013, the ERP will conduct the research that will produce guidance and decision support tools to target, prioritize, and evaluate policy and management actions that protect, enhance, and restore ecosystem goods and services of wetlands at multiple scales. Wetland ecosystem services will be examined in terms of wetland status and trends. Is an increase in wetland acreage sufficient? Wetlands provide a variety of services: recreation; regulation of nutrients, soil and sediment, and disturbances and natural disasters; cultural values and aesthetics; water supply; food production; and habitat and biodiversity.

Technical information transfer brings together research scientists, environmental professionals, and the public. EPA strives to provide the information where it is needed; collaborative production links the ORD ERP study with existing EPA program-funded wetland studies conducted by states and tribes.

Dr. Kentula described the ERP Wetlands Ecosystem Services Conceptual Model. It is necessary to know the direct and indirect drivers of change and how these affect abundance, distribution, condition, and supporting functions and structures. The ultimate impact on the regulating, provisioning, and cultural aspects of ecosystem services is determined and used for decision-making. The ERP has three research

questions: (1) How do drivers of change affect the ecological function of wetlands and the delivery of services at multiple spatial scales? (2) What is the relationship between the abundance, distribution, and condition of wetlands in the landscape and the delivery of ecosystem services? (3) What decision support tools are needed to protect, enhance, and restore delivery of wetland services at multiple spatial scales?

This research can be applied to the Great Salt Lake area. The Great Salt Lake is comprised of six wetland classes. Landscape profiles provide an ecological fingerprint of an area. They are characteristic of a landscape or region, show the relative abundance of functional types of wetlands, and have been generated through field work. The next step is to convert the landscape profile to a condition profile. The data and methods for this research have been published in the September 2007 issue of *Wetlands*. Following that step, a wetlands service profile will be generated through the new research to be done under the ERP. This involves knowing what the potential is for providing various services, examining current conditions, and using decision support systems to evaluate tradeoffs. There is great potential for using EPA's 1-2-3 Assessment Approach and the new research on wetland services.

A participant asked over what timeframe the approach could be enacted for the Great Salt Lake. Dr. Kentula estimates that it would take 1 year.

A participant asked if biodiversity and examination of carbon were being considered. Dr. Kentula responded that these are important components of the project.

Research To Evaluate the Feasibility of Using Wetlands in a Water Quality Trading Program: Achieving a Net Gain in Wetland Quality and Quantity

Joseph Schubauer-Berigan, EPA, ORD, NRMRL, Cincinnati, OH

Widespread implementation of watershed-scale trading could create opportunities to restore and construct wetlands as a means to generate pollutant reduction credits. Strategically located and designed wetlands could be used to improve water quality through the capture of nutrients and sediment, generating water quality credits that could be used by permitted dischargers to comply with National Pollution Discharge Elimination System permit limits. Additionally, taking full advantage of this opportunity could achieve water quality goals at a lower cost while attaining the President's goal to restore, improve, and protect at least 3 million additional acres of wetlands.

Significant losses of wetlands have occurred nationwide as a result of human activities. Despite progress in reducing the loads of several pollutants of concern (particularly point sources) to lakes, rivers, estuaries, and groundwater during the past 20 years, the quality of aquatic habitats in many parts of the United States continues to decline. Recent evidence indicates that 89 percent of the U.S. coastal estuaries show signs of impairment. It is recognized that wetlands provide an important, diverse habitat for a wide range of organisms and are crucial hydrological sites that hold water and moderate the downstream effects of flooding. Additionally, they are important sites of biogeochemical activity and key components in watershed restoration and management.

The current strategic approach will evaluate the feasibility of using wetlands in water quality trading programs in a way that informs national policy development and watershed planning. It is necessary to gain a comprehensive understanding of the role wetlands play in reducing and moderating stressors and provide better scientific information about how to successfully restore, enhance, and protect various types of wetlands in different areas of the country. Additional research needs include understanding when and where wetlands can play a role as innovative cost-effective best management practices (BMPs) for point source and nonpoint source controls and gaining a better understanding of the role wetlands can play as part of a potential nutrient trading program. Priority research areas include wetland science, water quality

and watershed modeling, economics, and decision sciences. Verification is important to determine if the practice will perform as expected.

The research assumptions of the project are that: (1) there is a net increase in quantity and quality of the nation's wetlands; (2) no degradation of ecologically intact, native wetlands is occurring; (3) the risk of unintended consequences can be quantified; and (4) environmental results will be confirmed via the collection of water quality data and data on ancillary ecological services. The study was designed to consider restoration of degraded or former wetlands (i.e., return of natural functions and services with controlled or passive delivery of water to the system) and wetland treatment systems (i.e., wetland restoration as part of a constructed wetland project, wetland restoration as part of a watershed or TMDL implementation plan). Initially, the researchers had full-time equivalents (FTEs) but no funding. Feasibility studies and a review of the state of the science were conducted, followed by a technical workshop to establish the state of the practice and identify research barriers to trading. Given funding, the researchers wanted to identify and evaluate ongoing wetland performance and trading projects; build partnerships; and develop, deploy, and test pilot projects.

Economics research gaps include performance, scale, ancillary benefits and ecological services, verification, and the cost of unintended consequences. Wetland science gaps include performance, scale, wetland trajectory, verification, and the risk of unintended consequences. Wetland groups develop engineering templates and watershed scenarios to analyze project performance and market viability of managed wetlands and large-river, channel-restored wetlands. Dr. Schubauer-Berigan provided examples of wetland templates, including recently restored wetlands in the Upper Mississippi River National Wildlife and Fish Refuge. Studies of these wetlands were conducted to measure their performance in removing sediments and nutrients.

Wetland benefit curves can be created that provide an account of composite and ancillary benefits that vary with time or space. These curves allow the comparison of relationships between key benefits or ecological services. They can help inform decisions about where trading may be more feasible. The current literature indicate that restored floodplain wetlands probably offer the best opportunities for use in a water quality trading program; depending on their size, the hydrologic regime and their age, floodplain wetlands can remove approximately 200 kg of nitrogen per hectare annually; under high nitrate loading rates, this rate can increase to 600 kg per hectare per year. Long-term phosphorus removal is considerably less at 20 kg per hectare per year. Although the rate of removal of nitrogen remains fairly stable with time, the removal rate of phosphorus can drop off precipitously with time.

A participant asked how engineered systems fit into a geomorphic classification and functionality context. Dr. Schubauer-Berigan responded that some are close to the original class. The language is important because of the regulatory structure; different groups insist on different nomenclature for the same item/factor. Some functions are similar to the groups they replace, but the more it is simplified, the more the system will look like a lake. The participant added that the system would not function like natural wetlands. Dr. Schubauer-Berigan replied that it would depend on the function and the type of wetland. Functions such as nitrogen removal and certain habitat functions, such as supporting shorebirds, may be very similar with respect to similar natural wetlands.

A participant asked for clarification about the point that wetlands are being lost despite an observed decrease in loading. Dr. Schubauer-Berigan replied that although point source loadings to water bodies on average have decreased, nonpoint source loadings are increasing. The main cause of wetland loss, however, still is habitat destruction and conversion. The participant asked if the concentration is increased as a result of the loss of water. Dr. Schubauer-Berigan answered that across the country the trend is toward decreasing water quality and an increase in the number of TMDLs and listed waters. For example, the hypoxic area of the Gulf of Mexico is increasing. It is a dynamic system, and the problem is

that there are very few effective tools such as wetlands, in addition to source reduction, to effectively deal with nonpoint sources. There are, however, well-known and effective tools to manage point sources, and they should be applied where possible to reduce these point sources.

Incorporating Wetlands in Water Quality Trading Programs: Economic and Ecological Considerations

Hale Thurston, EPA, ORD, NRMRL, Cincinnati, OH

Hale Thurston explained that economic trading is sensible when cost heterogeneity, increasing marginal costs of abatement, a regulatory driver, infrastructure (e.g., bank, clearinghouse, securitization), and relative certainty are present. He showed a classical, graphical representation of how trading works using the example of the cost of reducing pollution. Transactions costs, opportunity costs, maintenance costs, nonmarket costs and benefits, unintended costs and benefits, gamesmanship, discounting, intergenerational equity, banking, spatial fragmentation, scaling issues, and trading ratios affect the ultimate equity.

EPA wants to promote water quality trading and determine if wetlands can be incorporated into water quality trading. Additionally, it is necessary for researchers to identify the important factors. Water quality trading has grown in popularity and scope in recent years owing to its potential as a flexible, low-cost method to achieve water quality goals, especially nutrient removal goals. One issue, however, is the determination of why efforts have stalled. Work toward identifying the challenges has demonstrated that thin markets and political and economic factors all contribute. Some potentials solutions are to increase the market size by allowing the inclusion of wetlands and make explicit how ancillary benefits will be treated, include the ancillary benefits of a properly functioning wetland in the market for nutrient removal through subsidies and unique trading ratios, or allow a producer to trade the various services offered by wetlands in various markets (i.e., "double dip"). The most suitable option depends on the shape of the marginal benefits curve.

Dr. Thurston provided examples of economic equations, concluding that in terms of ancillary benefits, the change in price depends on the sign of the covariance term. The sign of this depends on the change in the variance of nonpoint source pollution given a change in the level of abatement. If the level of abatement decreases the variance of nonpoint source pollution, then the covariance is negative. Although it is intuitive that increasing the level of a specific abatement technology would always reduce the variance of the targeted pollution, this is not necessarily the case in complex systems such as wetlands. With ancillary benefits it is necessary to choose include the market with ratios and subsidies or use different markets for different benefits. Woodward and Han (2004) and Montero (2001) use a price versus quantity argument (first proposed by Weitzman, 1974) to decide whether to use single or multiple markets based on the shape of the marginal benefits curve. Marginal benefits curves, however, are not well understood in this ultra-complex setting. Therefore, current policy hinges on two complex ecological phenomena. Agglomeration bonus or other policy tools can be used to reduce uncertainty about benefits function.

A participant asked for an explanation of variance. Dr. Thurston replied that, in terms of treatment, it is intuitive to think that the range of runoff would decrease when runoff decreases, but sometimes it increases. The participant clarified that the concept applies to the variability of parameters.

A participant asked how this can be applied to the Great Salt Lake. Dr. Thurston responded that although the economics are detailed, they also can be generalized. It is the ecologists' responsibility to apply these concepts to the Great Salt Lake.

A participant asked what the literature suggests regarding water quality trading acceptance by the public and decision-makers. Dr. Thurston replied that ratios to date often have been primarily politically motivated, although they should be physically motivated. There is a perception that "double dipping" is unfair. Although economists can determine which option is best in theory, the best option in practice may be the one that is easiest to implement in terms of politics.

A participant asked what percentage of the program cost goes to the program activities. Dr. Thurston replied that currently a disproportionate amount goes to administration.

Ecological and Beneficial Use Assessment of Farmington Bay Wetlands

Theron Miller, Utah Division of Water Quality, Salt Lake City, UT

Dr. Miller explained that for every foot gained or lost in water level, 44,000 acres are gained or lost, respectively. The Great Salt Lake supplies important feeding and nesting grounds for migratory birds and provides habitat for waterfowl, shorebirds, and the aquatic life in their food chain. The Great Salt Lake brine shrimp industry is a $100 million annual industry.

The objectives of the project are to: (1) develop methodology for site-specific nutrient criteria and an associated methodology for beneficial use assessment to understand how the ecosystem works; (2) identify sensitive habitat, season, and food chain links; and (3) identify tolerance thresholds among important ecosystem components; and incorporate metrics into an index of biological integrity. The Farmington Bay study commenced in 2004 and measures environmental and biotic variables with a focus on shorebirds. The questions used to develop wetlands metrics are: What metrics are indicative of wetland condition? Are these metrics related to water quality?

The objectives of the shorebird study are to determine nesting habitat, nesting success, hatching success, and aquatic life in the shorebird food chain; previous water quality sampling fortuitously occurred near a shorebird nesting colony, providing the project with data. The vast majority of support for the project has been an SRF loan. Sites have been set up along the flow, and gradients have been examined. The hypothesis was that gradients would occur, but they did not. In terms of macroinvertebrates, tolerant species were more abundant at eutrophic sites, and sensitive species were more abundant at oligotrophic sites (e.g., reference sites). Plant species diversity at some wastewater treatment plants was higher than at reference sites. Plant diversity, however, may not be indicative of nutrient availability. Stomach contents by volume were examined at various sites, but bird preference and food availability must be taken into account. The analytical method shows general trends and relationships. A more sensitive tool is needed, however, to make the link between ecological function and benefit because, despite the collection of data, it is difficult to detect an impairment.

Seasonal percent cover data are being examined to determine what effects (e.g., nutrient levels, turbidity) are associated with the arrival of ducks. Researchers also are beginning to determine if diatomous mucilage is associated with water quality issues. To address remaining data gaps, efforts are needed that: determine the relative importance of shading, waterfowl foraging, carp foraging, and potential stress from excess phosphorous in the impoundments; quantify nesting habitat characteristics in terms of plant communities and proximity to water; and quantify shorebird juvenile survivability and link this to habitat and food resource requirements.

A participant commented about the anthropogenically derived nutrients that enter the Great Salt Lake watershed and asked if researchers consider how close to a major collapse the system might be. Dr. Miller replied that it is considered, and this is a major question. The participant cited the example of the unexpected collapse of the blue crab in the Chesapeake Bay. Science may not have the answer to the question. Dr. Miller agreed and explained that the mouth of the Jordan River is in poor condition, with no

submerged aquatic vegetation (SAV), midges, bugs, and so forth. Using these data gathered about the Jordan River, it may be possible to determine the characteristics of a collapse.

Dr. Schubauer-Berigan asked if phosphorus removal is sustainable. Dr. Miller responded that the science of this has been debated for approximately 3 years. The sediment contains large amounts of phosphorus, so if water quality removal of phosphorus is performed, the question is: What is the ability of the residual phosphorus to resuspend in the water column? Along with impairment and TMDL, this is vital, and researchers must determine what viable alternatives are available.

Panel: An Alternative Futures Approach to Watershed Evaluation

Richard Sumner, EPA National Wetlands Program, Corvallis, OR (Facilitator); Richard Toth, Utah State University, Logan, UT; Dixon Landers, EPA, ORD, NHEERL, Corvallis, OR

Mr. Sumner explained that this panel would focus on various methods and approaches that assist in the development of scenarios that can evaluate ecosystem services and help determine an economic approach. He introduced Richard Toth, who spoke about alternative futures for the Bear River Watershed.

Dr. Toth explained that the research project was a year-long effort that involved graduate students from many different disciplines, including natural resources, biology, history, philosophy, and mathematics. The Bear River Watershed, located in northeastern Utah, southeastern Idaho, and southwestern Wyoming, covers 7,500 square miles. The Bear River crosses state boundaries five times and is the largest river in the western hemisphere that does not empty into an ocean. Major water uses in the Bear River Watershed include agriculture, power generation, recreation, and municipal and industrial uses. Major issues identified for the watershed include water quality and quantity, quality of life, agriculture, Bear Lake, transportation, air quality, and growth management.

The goal for alternative futures is to illustrate potential future scenarios for the watershed based on different assumptions. Assessment models reflect the identified issues and are used to evaluate alternative futures and to assess any additional futures' effects on designated qualities. The approach to the project was to perform pre-analysis followed by data inventory and base map preparation. Following this, a full-scale analysis was performed. Evaluation criteria and environmental assessment models were used to create and evaluate alternative futures. The entire concept then was evaluated, which in turn generates more concepts to be field-tested. These new concepts then follow the same approach, starting with pre-analysis. Therefore, the approach is cyclical in nature.

The various activities of the pre-analysis stage—including over-flights and field trips of the study area, review of past case studies, meetings with stakeholders, and project opinion papers—accomplished three objectives: (1) The context and scale of the study area was set. (2) The issues that needed to be addressed in the analysis stage of the project were determined. (3) The types of data that were needed for future work were identified. The full-scale analysis, which analyzed climate, culture and history, hydrology, soils and geology, and vegetation and wildlife, separated the study area into its parts so that its function and structure could be described and understood. The evaluation criteria define the functional and spatial requirements, including infrastructure, commercial and institutional, industry, working landscapes, summer and winter recreation, and residential housing. The assessment models incorporate the evaluation criteria into spatial models of essential issues, such as ground and surface water; wetlands; wildlife; public health, welfare, and safety; infrastructure; rural quality of life; and critical lands.

Future models represent potential alternative futures. Each future illustrates a potential scenario based on different assumptions regarding growth, infrastructure, and so forth. Some models account for differing levels of expected growth, whereas others consider different features and their incorporation into the watershed. This project examined some growth-oriented futures (e.g., growth potential, plan trend,

double expected population, new big towns, and expanded small towns) and feature-oriented futures (e.g., public transit, regional parks and trail system, and destination resorts). Groundtruthing and use of assessment models as evaluation tools are employed to determine if the plan is sound. New strategies and/or alternatives, new tools of implementation, and new land use activity and evaluation models are considered.

In selecting assessment models, Critical Lands Assessment combines public health, welfare, and safety; wetlands; surface water; groundwater recharge areas; and critical wildlife habitat. The project evaluated four features using the Critical Lands Assessment: plan trend, double expected population, new towns, and traditional communities. These four futures were selected because they all accounted for future growth; the feature-oriented futures were not assessed because they did not account for future growth.

The researchers concluded that assessment models and futures are not comprehensive, as many additional scenarios are possible. Local input and discretion is recommended for the prioritization of issues. Wise choices made today will result in a healthier environment, smarter development, and a higher quality of life for residents. The Critical Lands Assessment identifies critical land "hot spots" (i.e., areas of high preservation) and areas where new developments could occur in proximity to existing infrastructure. Development would occur based on the preservation of critical lands.

A participant asked if a buffer was placed on wetlands during the Critical Lands Assessment. Dr. Toth replied no, but a 50 m buffer was used in very specific cases.

A participant asked what percentage of critical lands is private and how people react. Dr. Toth answered that private property issues do arise, and people's reactions vary. A gradual approach should be taken to address these matters.

A participant asked if water availability for consumption was being considered. Dr. Toth responded that this was not incorporated into the assessment models that the project evaluated, but it could be. Much information is not available, and it must be added later.

A participant asked if the student's plan that was adopted by the government was available. Dr. Toth directed participants to the Cache Valley 2030 Web Site (http://www.cachevalley2030.info) if they were interested in viewing the plan.

Mr. Sumner presented information about the Blackberry Creek Watershed alternative futures analysis. The design points of the project were a series of questions that asked the following: How should the state of the landscape be described? How does the landscape work? How does one judge whether the current state of the landscape is working well? By what actions might the current landscape be altered? What predictable differences might the changes cause? How is a decision made to change or conserve the landscape?

Flood damages continue to increase despite significant expenditures on flood control, because the rate and volume of runoff have increased. Agriculture was the first anthropogenic change to the landscape as farming depleted the soils of organic carbon. The most recent change is urbanization, and the landscape has been converted from one that is efficient at holding water to one that is efficient at shedding water. From prairie to urban use, each setting is built from existing conditions.

The project began by an evaluation of various green infrastructure scenarios. Critical lands with good attributes were identified to determine where green infrastructure would fit. Conservation structures were imported onto a map of current features, and several scenarios were examined. Visual images were created for decision-makers to view. The watershed evaluation is represented by the TQmean, which is defined as the proportion of time that flow is greater than the mean flow; higher is better. Three points

within the watershed were examined, including a county line point, and it was determined that given the conditions of TQmean; 7-day, 10-year low flow; and 1-year discharge, the conservation model was superior to the conventional model and existing conditions. Several entities have adopted BMPs as a result of this work, including the cities of Aurora, Batavia, and Yorkville; the villages of Elburn, Montgomery, North Aurora, and Sugar Grove; and Kane and Kendall Counties. The next step is to perform an economic evaluation.

Dixon Landers provided information about the Willamette Ecosystem Services Project. The Willamette Ecosystem Services District has the largest concentration of population and wealth in Oregon, and as a result there are many stressors in the area. The overall goal of the project was to provide a scientific basis in the form of a decision support system for valuing and projecting ecological services resulting from alternative management decisions. The specific objectives are to: (1) provide a model-based approach that predicts responses of ecosystem services to probable future conditions; (2) identify critical knowledge gaps in the ecological processes underlying ecosystem services; (3) quantify ecosystem services, including their distribution, status, and responses to current and projected future conditions; and (4) evaluate net benefits of bundled ecosystem services and tradeoffs among management actions that affect these services. The Willamette area was chosen because it offers a climate of rich opportunities and contains a convergence of interests with a consistent record of cooperation.

The project explored place-based societal issues and values, with the research targeted to develop ecological response functions and ecological tradeoff functions. An essential component of the project is inventorying and mapping the location and value of ecosystem services because it is necessary to know what the ecosystem services are and how to measure them. Project terms include "forcing variables," which are defined as natural and anthropogenic factors that affect quantifiable changes in the status of ecosystem processes, and "ecosystem response function," which is defined as the relationships between ecosystem services and the natural and anthropogenic forcing variables affecting them.

Land use categories of interest for the project were coniferous forests, agricultural land, and riparian wetlands. Additional ecosystem types were rated on expected change in spatial extent of ecosystem type, impact on service, and knowledge gaps in an attempt to prioritize.

Ecosystem tradeoff bundles are relationships between two or more ecosystem services in the same forcing variable and eventually multiple forcing variables. If ecosystem response functions are taken together, these bundles are created; conceptually, this is how bundled services can be examined. It is important to be able to move back and forth between various scales, ranging from plots to the entire basin. It may be possible to scale up to the regional level with additional information. The project's goal (expected to be reached during the 2013 fiscal year) is to equip staff members of EPA Region 10 with decision-making tools to evaluate bundles of ecosystem services and identify options for their management and protection in the Willamette Ecosystem Services District.

A status assessment was performed to determine strengths and weaknesses of the project. Strengths include the existence of a strong research experience, strong division support, an excellent and engaged research community, and pledges of collaboration and engagement to Region 10, the primary client. Weaknesses include a need for additional expertise in critical skill areas such as evaluation and spatial eco-economics; the need for creative, young, and experienced modelers; and a restrictive budget. This may be the beginning of a new paradigm; a fundamental vision exists, but it must be expanded.

A participant asked if decision-makers are aware that this type of process can benefit them. Dr. Landers responded that decision-makers are aware of the potential for an ecosystem shift. They want to avoid a shift, but they are unsure of the likelihood that a shift will occur in their region. The process described can help decision-makers determine how many decision are too many in terms of keeping the ecosystem going.

Panel: Assessment of Great Salt Lake Wetlands

Mary Kentula, EPA, ORD, NHEERL, Corvallis, OR (Facilitator);Terry Johnson, Utah Department of Transportation (UDOT), Salt Lake City, UT; Brian Nicholson, SWCA Environmental Consultants, Salt Lake City, UT; Michael Sipos, BIO-WEST, Inc., Logan, UT; Heidi Hoven, The Institute for Watershed Sciences, Kamas, UT

Terry Johnson explained that the UDOT determined that there was a need to look at wetland functions and perform a wetland functional assessment. They based their model on the successful Montana DOT method and contracted with Utah State University to develop a new model adapted to wetlands found in Utah. Mr. Johnson provided an example of the matrix used in the assessment and explained that once the matrix had been completed, a rating could be assigned. The rating places the assessed system in one of five categories.

Brian Nicholson explained that some assessments were driven by regulations by the U.S. Army Corps of Engineers (USACE). The functional assessment method is used for regulatory (e.g., developing special area management plans) and National Environmental Policy Act (NEPA) processes. The functional assessment was implemented to answer the following questions: (1) Can a value be placed on wetland resources within a study area to prioritize areas for preservation or development? (2) As part of the NEPA process, how do researchers assess the impacts to wetlands of different options beyond the typical acreage measurement? The group used a hydrogeomorphic-type functional assessment model developed by Dr. Nancy Keate of Utah Wildlife Resources. The model has six functions: water storage, water delivery, particulate retention, dissolved compound processing, wildlife habitat, and wildlife activity. In the one example presented by Mr. Nicholson, an area was divided into 15 different wetland functional units based on wetland type, hydrology, modifications that would separate the wetland complex, and surrounding land use. Land use is a surrogate for disturbance and will affect the six functions listed above. Ultimately, a functional capacity score/ranking is determined. In this case, a score can be used to identify areas suitable for development while preserving medium to high functioning wetlands. Additionally, functional capacity units (assessment score multiplied by wetland acreage) also can be calculated to further quantify and qualify wetlands.

Michael Sipos stated that the objectives of his assessment are to: (1) assess pre- and postimpact habitat conditions for wildlife, (2) facilitate the process of developing compensatory mitigation ratios, and (3) monitor the progress of restoration and mitigation efforts relative to baseline or reference conditions. In terms of the habitat quality index for avian communities, the group has conceptually made three classifications: abiotic and biotic structure and hydrology. Classes of habitats have been determined but can change. Metrics include vegetative (spatial patterning of vegetation across landscape), species (native vs. invasive, nonnative), and soil (texture, compaction).

Heidi Hoven explained that her projects assess both condition and function of Great Salt Lake wetlands. The goal of many of her projects was to determine baseline measurements of the wetlands before any changes (e.g., management schemes, restoration, mitigation) were made to determine any trends over time. Currently, she collaborates with the Utah DEQ to develop metrics to assess wetland condition as a predictor of water quality of Farmington Bay, as previously described by Dr. Miller. Metrics related to SAV for impounded sites will be examined, such as plant physiology metrics and light attenuation in the water column to determine a more direct link between condition and stressors. Many of the data from her work and others can be used to develop a universally accepted Utah Rapid Assessment Method (URAM) for wetland assessment. Her wildlife functional assessment model and/or the BioWest habitat quality index may be used to construct a habitat component for the URAM. This component will evaluate from a landscape scale what level of habitat function that wetlands provide wildlife, particularly shorebirds. In developing the URAM, there will be a crossover between condition and function metrics, either providing

support data for calibration of the method or in developing a reference wetland network. The reference network will be representative of the spectrum of poor to good quality wetlands.

Wrap-Up: Setting the Agenda for Research of Great Salt Lake Wetlands

Mr. Sumner explained that the Great Salt Lake is a valued resource for a variety of reasons. The focus must be on how to connect and collaborate to protect and restore it. The concept of ecosystem services was explored during the day's session. The next step is to look to the future and determine goals. Stakeholders must determine where they want to be in 30–50 years, and create scenarios that will help protect the Great Salt Lake during this timeframe. It is necessary to evaluate the consequences of the various scenarios. The next day's session will begin to explore a potential research project that will create scenarios for a portion of the Great Salt Lake watershed (e.g., Farmington Bay) and determine how these scenarios can be assessed. This information then will be used to determine the objectives for creating the alternative futures. Tomorrow's sessions also will consider stressors and problems with an eye toward identifying possible solutions.

September 27, 2006

Overview of Planned Research

Richard Sumner, EPA National Wetlands Program, Corvallis, OR (Facilitator); Joseph Schubauer-Berigan, EPA, ORD, NRMRL, Cincinnati, OH; Jill Minter, EPA Region 8, Denver, CO

Dr. Schubauer-Berigan explained that the purpose of his project is to: (1) analyze the consequences of various management scenarios in the Farmington Bay area of Great Salt Lake, (2) produce three GIS-based spatial models for futures scenarios in Farmington Bay, and (3) examine the potential integration of a water quality trading program in the Farmington Bay area. The desired project outcomes are to: (1) complement ongoing research efforts currently in the Farmington Bay area, (2) help the Farmington Bay community make informed decisions regarding planning and water management, and (3) present strategies for easing pressures on wetlands and wildlife.

The project timeline is as follows: (1) finalize the Quality Assurance Project Plan by September 2007; (2) assemble the design team by October 2007; (3) perform a site inventory and literature review by October 2007; (4) develop a GIS map and database by November 2007; (5) conduct an on-site planning workshop in December 2007; (6) develop a template and GIS model by March 2008; (7) evaluate scenarios via models by May 2008; (8) produce the draft feasibility report by June 2008; (9) convene an outreach workshop to discuss the draft report in July 2008; and (10) submit the final feasibility report by December 2008. This report will be more than a project report; it will be a document that stakeholders can use as a road map.

The alternative futures scenarios will examine conventional development. The project will define a current scenario, estimate a historic scenario, and create three futures scenarios. An appropriate end year will be determined for the future scenarios. In addition to the projects discussed at this meeting, a variety of alternative futures scenario frameworks exist to inform the project, including the Wasatch Range Open Space Study, Utah; Monroe River, Pennsylvania; and Camp Pendleton, California.

Water quality trading is a new concept to EPA, although states are developing their own programs. Water quality trading in nonpoint source pollution credits can come from stream bank restoration, conservation tillage, and erosion control. The hope is that wetlands can be strategically constructed or restored to reduce nitrogen, phosphorous, and sediment effluent from wastewater treatment plants. By evaluating the functionality of existing wetlands and identifying areas suitable for restoration or protection, wetlands then can be used as credits. Challenges to implementing water quality trading include the limited

examples, lack of research, and the issue of liability. The following questions need to be considered: Can a wetland monitoring and assessment network be implemented to measure wetland condition and wetland performance for nutrient management? How might we account for unintended consequences? How much opportunity exists in the study area for wetland restoration and the implementation of related BMPs? Do administrative and financial incentives exist for evaluating the feasibility of a trading program?

A participant asked what the funding mechanism would be for a third party mitigator. Dr. Schubauer-Berigan responded that it would be created from a tradeoff with the person trying to buy credits. Mr. Sumner explained that the economic issues cannot be solved until the science is completed, so it is difficult to answer that question with current information.

A participant commented that water quality trading credits should include land acquisition and conservation. Currently, too many temporary measures exist. Dr. Schubauer-Berigan replied that the wetlands program is considering a permanent addition to functioning wetlands and resources. Water quality trading programs, however, may have a different outlook. The participant asked if the boundaries of the project were defined. Dr. Schubauer-Berigan responded that when the design team is in place, the boundaries will be determined. The project will focus on shoreline and water level changes. Mr. Sumner added that there is flexibility to determine how the problem and boundaries will be approached. Ms. Minter explained that the project will have Agency input as well.

A participant advised not to dismiss conservation efforts because wetlands around the Great Salt Lake are being lost, and water quality trading efforts should not interfere with conservation efforts. Dr. Schubauer-Berigan replied that this is being considered and is the reason why partitioning of tradeoffs is being investigated.

Leland Myers, Central Davis Sewer District, asked at what level the project was going to examine this issue. Dr. Schubauer-Berigan replied that some of the stressors will have to be examined, and a driver will be necessary. Mr. Myers asked how this was going to be related to the salinity issue. In the Farmington Bay, salinity is maintained at an artificially low concentration compared to the lake. How will the salinity concern be examined in the context of water quality trading? Dr. Schubauer-Berigan responded that this factor will be considered, but at this time, it is unknown how the issue will be approached. Mr. Sumner added that the design team will offer various options. The scenarios will define a template, and administrative features can be identified to achieve the desired quantity and quality. This project is not specifically a water quality trading project, but it will explore this issue. Mr. Myers stated that the issue of how to improve wetlands should be examined holistically. Dr. Schubauer-Berigan explained that the project will be performed by layers, with a conservation layer and a trading layer applied on top of this.

A participant asked if a problem statement has been established. Dr. Schubauer-Berigan replied that a proposal and a circulated contract are available. Mr. Sumner added that the group is in the problem formulation stage right now because there are many issues (nutrients, salinity, etc.). Degradation and conservation issues must be kept in balance.

A participant asked if project researchers were considering using Envision Utah as a resource. Mr. Sumner replied that researchers did want to use the partnership. The participant explained that a 10-year report is being released next month by Envision Utah, and this should be placed in the project toolbox.

Dr. Miller explained that much of the at-risk land is private land, so the issues are in managing this type of development scenario and determining if pollution credits for trading can be used as a mechanism to secure high-priority wetlands.

Dennis Wenger, Frontier Corporation, USA, commented that needs and opportunities must be considered and balanced. Water quality is comprised of two spheres: municipal water treaters within a specific geographic area, and growing municipalities, which are geographically dispersed. On the Wasatch front, water has been dumped into irrigation infrastructure and is then distributed among the users. The satisfaction with this system is decreasing and there are problems with irrigation versus collection systems. Irrigators are receiving too much low-quality water. A solution may be to separate the stormwater and the irrigation water and use the municipal stormwater for restoration and treatment of wetlands and agricultural lands that may otherwise be subject to development pressure. Because this would be a municipal project, the opportunity exists to form a special service district, which would have the authority to raise taxes, acquire land, and hire staff. The needs of the stormwater managers are different than the needs of the treaters, and the hydrology will be different.

Mr. Sumner commented that there is point and nonpoint load, and point load can be split into storm- and wastewater sections. He asked Florence Reynolds of the Salt Lake City Corporation Public Utilities Department to offer her input. Ms. Reynolds stated that public utilities recognize that there are development issues in the northwest quadrant and that the research is not complete regarding nutrient loading and the feasibility and practicality of addressing the issue using storm- and wastewater.
Mr. Sumner asked how the project researchers could best coordinate with the public utilities.
Ms. Reynolds replied that communication is the best tool.

A participant commented that so much is happening with population changes that it is difficult to pinpoint the consequences and examine alternative future scenarios. Mr. Sumner replied that land use changes can be projected. Additionally, technological strategies can be examined and the two issues can be integrated.

Maunsel Pearce, Great Salt Lake Alliance, remarked that it is alarming that no wetlands trading programs exist and now one is being attempted in a very unique system. Dr. Schubauer-Berigan explained that this is not a wetlands trading program; it is a project that is using wetlands in a water quality trading context. Dr. Pearce stated that he has concerns regarding how this can be carried out over the long term and still be protected. Mr. Sumner agreed that he has the same concerns and speculated about how to bring market forces to bear on environmental protection and conservation. Market forces are very powerful if they can be harnessed properly. The question is how this is translated into trading.

A participant commented that this work and GIS work with wetland mapping are providing a significant opportunity to discover tools. Another participant added that large information gathering efforts can inform decision-makers of the consequences of their decisions. Dr. Schubauer-Berigan stated that part of the project is to determine what information is needed. An important aspect is determining where data gaps exist and how significant the gaps are. Dr. Miller reiterated that these are tentative scenarios that may or may not work; this is strictly a research question.

A participant stated that it is important to consider, as things are broken into parts, what the desired current and future conditions will be. It is important to understand that the Great Salt Lake is unique in terms of its salinity and limnology. How wetlands affect other aspects of the ecology of a system must be considered in addition to how wetlands function in and of themselves.

Panel: Understanding the Threats to the Wetlands of the Great Salt Lake

Jill Minter, EPA Region 8, Denver, CO (Facilitator); Pam Kramer, Utah Division of Wildlife Resources, Salt Lake City, UT; Jason Gipson, USACE, Bountiful, UT; Leland Myers, Central Davis Sewer District, Kaysville, UT; Nathan Darnell, U.S. Fish and Wildlife Service, Salt Lake City, UT; Maunsel Pearce, Great Salt Lake Alliance, Salt Lake City, UT

Pam Kramer explained that the Great Salt Lake is marked by a continually changing water level, both seasonally and annually. This results in a diversity of wildlife. Brackish, fresh, and salt water influences the vegetation, and birds continually shift their location while looking for their desired habitat. Salinity changes affect the brine population. Threats to the Great Salt Lake include anthropogenic loss, direct and indirect loss as a result of filling, pollutant runoff, stream channel alterations, annexation of wetlands by cities, temporal loss despite mitigation, invasive species, loss of wildlife nesting and foraging habitats, aggressive growth of *Phragmites* and other nonnative plants, loss of buffers, and planned dams. Additionally, educating the public has been a challenge. It also is necessary to examine upstream problems in a watershed context. Actions that need to be taken include: (1) mapping of Great Salt Lake wetlands to quantify the amount of wetland loss so that the success of mitigation can be assessed; (2) protection of fringe wetlands important to wildlife that are not currently protected; (3) control of nonnative, invasive species; and (4) restoration of wetlands and establishment of water quality and quantity.

Jason Gipson explained that USACE is a permit agency, not specifically a protection agency, although it attempts to protect from a permitting standpoint. Threats to the Great Salt Lake include loss as a result of development because prices are lower for land with wetlands, needs for infrastructure as a result of development, conversion to other wetland types as a result of waterfowl management, and noxious weed invasion. Mr. Gipson showed several slides that provided a visual depiction of permitting actions surrounding the Great Salt Lake that USACE has taken in the past. He explained that the number of permit requests have increased dramatically. Ecosystem services are being lost because of development. Water quality, quality of surface water sources for drinking water, and groundwater have increasing degradation in terms of pH, turbidity, and temperature. Decreases in wildlife habitat, recreational areas, and carbon sequestration also are occurring. USACE is performing an acre-by-acre assessment in an attempt to gain a holistic view of changes occurring in the watershed. USACE also is employing in-kind mitigation efforts. Mr. Gipson supported the idea of examining the watershed in four quadrants and not as whole because there are different densities in each area. The examination of specific components informs the locations that should be developed. Cumulative assessments that would provide a better idea of impacted areas and possible future directions are lacking.

Mr. Myers stated that there are many potential threats to Farmington Bay that need significant investigation. The following questions need to be answered: What is wrong? Is it different from the past? Can the problem be fixed? A dedicated political organization is needed to oversee and protect the lake and its surrounding wetlands. Farmington Bay is a highly managed system, and the delivery system from the Jordan River is fragmented by canals, channels, drains, and so forth. None of the water movement is environmentally driven; it is stormwater and water management driven. It must be environmentally driven for positive changes to occur. Additionally, water quality is not part of flow management decisions. Approximately 4,000 pounds of phosphorus per day enter the bay, with an outflow of 1,200 pounds per day, which causes a sink of 3,000 pounds per day. Water quantity is important to the bay, and current conditions are anthropogenic. Change cannot occur until the appropriate measures are taken to manage change.

Nathan Darnell explained that the wetlands are drying up as a result of many years of drought. It is possible that when the drought ends, these wetlands will be re-established, unless they are developed in

the interim. This may be difficult to perform politically, but it needs to be addressed. The Great Salt Lake is a major habitat for resident and migrating birds. Other portions of the lake outside of Farmington Bay need to be considered. Contaminants in the lake include metals, organochlorines, hydrocarbons, and endocrine disrupting compounds, and Farmington Bay has significant issues with mercury. Birds are accumulating mercury from the Great Salt Lake. The mercury source, whether aerial or ground, must be determined. Additionally, there is a history of organochlorines and DDT mixing with water during mitigation efforts to create wetlands, which kills significant amounts of birds. Contaminant surveys must be completed before mitigation efforts to create wetlands are undertaken. Cyanotoxins in the lake are significantly higher than World Health Organization standards. Disease transmission between birds also is a concern as the bird population density increases. Stormwater use may be one possible method of mitigation. It is important to determine how clean water can be routed to the lake at low cost so that there is no temptation to profit from the clean water by selling it to others.

Dr. Pearce explained that the 9-year-old Great Salt Lake Alliance is comprised of leaders from nongovernmental organizations and conservation groups. It is successful in coordinating actions related to the lake. Steps to conservation action planning include project definition, strategies and measures definition, strategies and measures implementation, and use of results to adapt and improve. To categorize threats to the Great Salt Lake, target systems that comprise the lake—including an avian ecological group, plankton ecosystem, brine fly, seasonally flooded playas and shoreline mudflats, freshwater wetlands and riparian systems, and upland vegetations and floodplains—were defined and their stressors identified. The stressors were rated and consequently ranked in terms of research priority. Overarching threats to the Great Salt Lake ecosystem are related to lake management. Managers are in a reactive and not a proactive mode, because no single definition of a healthy, sustainable Great Salt Lake ecosystem exists and management styles and research are fragmented.

Ms. Minter called for participant comment following Dr. Pearce's presentation.

A participant asked if it was panel members' opinion that the biggest problem facing the Great Salt Lake is that there is no coordinated political group. Mr. Myers responded that he believed it was. Current managers have different priorities and biases and protect their own domain; these entities need to be consolidated so that meaningful coordination can occur. Dr. Pearce stated that in his opinion, water quality and quantity issues are the most critical; it would be useful to coordinate these issues. Mr. Gipson stated that from a USACE perspective, it is important to have a single entity managing the Great Salt Lake and its issues, but before the group can manage the watershed, it is necessary to determine the current state of the watershed. Ms. Macauley added that a coordinated effort should be in place before a political entity is formed. Mr. Darnell stated that a commission is an important and valuable impetus to coordination, but it must define its goals explicitly so that management is effective.

Mr. Nicholson commented that data have been collected extensively; there must be a use for these data. Dr. Schubauer-Berigan stated that a Web site is needed that compiles data into a central database that is accessible to everyone. This would encourage researchers to share data freely.

A participant stated that there are capable individuals in the state government, but the political paradigm needs to be changed because Utah is commodity-driven in terms of managing its resources.

A participant asked about the status of Brigham Young University's management of a portion of the Great Salt Lake. Mr. Myers responded that he was unaware of the status, but he did not believe that it was focused on holistic management of the lake. The participant asked how holistic management of the lake by a single entity could transpire. Mr. Myers explained that an appointment from the governor could achieve this. The participant asked how the effort could be funded. Mr. Myers responded that funding mechanisms include federal grants and general funds. Educating the public to understand the cost of tertiary treatment also could help generate funds.

Dr. Keate stated that a model for this type of managing group exists; the group may not need to be a political entity. Ms. Minter agreed that there are many actions and activities that can be initiated while the group is being created. Other models exist for an open database. The database, tracking systems, and alternative futures projects can be established to better manage resources in the future and prioritize projects.

Dave Grierson, Utah Department of Natural Resources Division of Forestry, Fire, and State Lands (DFS), stated that his division does not own the lake. It is a federal lake owned by the public, and DFS manages it based on a public trust doctrine and legislative mandates. Additionally, there are external pressures from political entities, industry, and conservation groups to manage the lake in a certain manner. The Great Salt Lake Tech Team is developing a Web site that will be a central clearinghouse for Great Salt Lake data. The Great Salt Lake Authority is underfunded and not given the appropriate authority to manage the lake. As a result, different models (commission vs. authority) were debated when the Utah Lake Commission was created. Many different authorities existed, but none would not relinquish control so a commission was created to deal with various issues of the lake. The result has been increased cohesiveness.

A participant asked Mr. Grierson whether funding requests were moving forward. Mr. Grierson responded that the governor and state legislature were being asked for funds for the Great Salt Lake. The participant asked what type of budget was requested. Mr. Grierson responded that $300,000 had been requested.

Group Discussion: Clarifying Study Goals and Objectives

Mr. Sumner explained that this scientific research project can be a model used to form a design team that can formulate a template; the scientific team will perform the research. The project is a microcosm. It will have a quick turnaround time, and the results will be presented to the Agency where ideas about how to proceed can be formulated.

A participant stated that an increase in water quality and quantity is the presumption, but there is no problem statement. Ms. Minter replied that this is part of the work toward meeting the national goal set by President Bush.

A participant commented that there is going to be a population increase and change in land use. The focus should be on what will affect the ecological and environmental issues. Becoming proactive instead of reactive should be a goal, and an appropriate process for establishing a problem statement must be developed.

A participant stated that the biggest threat to collective success in helping the lake is bad science; researchers must ensure that the science is accurate. As personal conclusions crept into many of the remarks made during the meeting, he is concerned that different agendas may become a problem. The concept of a single political entity is appealing, and there is no reason that the group cannot start efforts now instead of waiting for additional research.

A participant commented that the project described is a research process to discover and understand data. The missing piece is policy analysis. If the belief is that there is not enough current data, it is necessary to ask why that is so. The dimensions that govern the Great Salt Lake and various budgets are unknown. It will take longer to reach a communal understanding without this knowledge.

Mr. Sumner stated that if the focus continues to be on resources, technology transfer needs will be missed. Fragmented decision-making also must be addressed.

A participant asked what factors about a policy system make it necessary to collect more data and why the data do not exist. Another participant commented that it is necessary to bring together all groups to share data and determine what data gaps exist. Various interest groups should be created immediately. Mr. Sumner suggested that a possible organizing theme could be to understand the current water budget, what decisions are being made, and who makes them.

A participant asked what the timeline was for receiving funding and how EPA viewed fragmentation. Jim Berkley, EPA Region 8, explained that as the Great Salt Lake Coordinator, he is working with the Utah Division of Water Quality to understand the nature of the problems Great Salt Lake stakeholders are struggling with. The EPA approach is to provide support and assist in integrating and approaching the issues. EPA is not a monolith. ORD has a particular focus, and ORD's agenda must be balanced with institutional challenges that exist within the Great Salt Lake Basin (e.g., politics, developers). Mr. Sumner added that EPA has a role in creating a forum such as this one. Ms. Minter explained that she reviews various proposals and participates in the selection process. There are opportunities to negotiate final work plans, coordinate across projects, and develop strategic approaches to create a program. One challenge is that the State of Utah does not have a clear plan for Great Salt Lake wetlands in a watershed context. Once a clear plan is in place, this should inform the proposals that are submitted and funded. The hope is to improve the funding process so that it is more efficient and effective.

Ms. Macauley stated that to integrate Great Salt Lake management, it is necessary to identify entities that have gathered data regarding the Great Salt Lake so that when it is time to build the database, the resources are in place. Key players involved in planning and policy decision-making also need to be identified. Dr. Schubauer-Berigan stated that the opportunity for posting data already has been created, and the Web site was recently launched.

Mr. Sumner stated that coordination begins with the Utah DEQ because of the multiyear relationship that is now expanding to include more groups. Dr. Schubauer-Berigan added that the research side is examining how to work through this process. The goal is to learn from this experience and apply project successes and mistakes elsewhere. Dr. Sumner stated that EPA is creating five testing sites across the country. Sharing experiences can be linked to these projects.

A participant asked if the project includes a steering committee or if it was looking for a guiding organization. Mr. Sumner replied that this type of guidance would be desirable. Sometimes such groups exist, but other times an audience must be created.

A participant stated that EPA is launching the effort and providing funding and administrative support, but this problem needs a locally generated body headed by a devoted local leader. Mr. Sumner agreed but stated that it is a challenge to find such a leader. Dr. Keate stated that there is a state planner that can arrange for this. Mr. Martinson commented that the legislature could be approached with a clear plan for this time-sensitive matter.

A participant asked if the Utah DEQ has an FTE. Ms. Macauley responded that the FTE is in the TMDL section.

A participant commented that MOUs are important to keep everyone in the process. Conservation guidance should be part of the group, but authority should be derived through agreements.

A participant stated that because this is a local problem, EPA cannot be expected to go beyond coordination of efforts. The people of the Great Salt Lake area should be protecting the resource. EPA can help coordinate and provide funding, but the passion should be local. Unfortunately, local residents are unsure what entity is responsible for the health of the lake. Another participant added that the assembled researchers could gather the data, but a political group is needed to enact and enforce changes.

Mr. Sumner commented that many researchers are performing good research. As researchers try to find technical answers, they must help political authorities recognize that good research is being performed and solid data exist. If researchers can account for the ecosystem services being sustained by management agency actions, then political entities will be more inclined to increase budgets for Great Salt Lake protection and restoration. Researchers must highlight their research and bring to the public's attention the problems of the Great Salt Lake. More importantly, they must also offer practical solutions that can guide future environmental decisions.

Mr. Martinson asked what the next steps are for the group. Ms. Minter explained that a report capturing the salient points of the workshop would be prepared and placed on an EPA Web site. In terms of the RARE project, EPA will develop a communication strategy to share the results of the project. One of the goals of EPA's National and Regional Wetlands Program is to develop wetland programs in each state via Wetland Program Development grants and interagency and partner efforts. Information on best practices and grant products must be made available to others; she is working on this. Dr. Miller at the Utah DEQ can be a point of contact, and Mr. Berkley is the point of contact for internal coordination at EPA Region 8. A draft prospectus for the Great Salt Lake Wetland Goals Project is included in the meeting materials, which focuses on monitoring and assessment, and can be used as a resource.

Mr. Sumner stated that EPA staff are internally organizing to address Great Salt Lake research. The Great Salt Lake stakeholders also need to become organized for both groups to be able to collaborate efficiently. A scientific program should be developed that provides monitoring and assessment. Dr. Schubauer-Berigan added that it is helpful for EPA to know with whom to communicate. Creation of some form of overarching group will be helpful to have a more effective outcome. The San Francisco Bay Institute is a good example of a nongovernmental agency that works with various types of agencies to perform science work with the ability to effect change.

A participant stated that Dr. Hoven could supply the summary review. Dr. Hoven clarified that it already is available at Mr. Myers' Web site.

Mr. Sumner adjourned the meeting at 12:15 p.m.